BUDT758N Group Project

FINAL REPORT

For

Parkinson's Disease Tech (PDT) - Software Architecture for AI Diagnosis and Therapy Using Voice Patterns

Group Members:

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Team Project 4b: Fengyi Zhao, Jin Sun, Xiang Gao, Jiangkun Xiong, Zhuxuan Xu

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Executive Summary

Parkinson's Disease Tech(PDT) is seeking to research and develop an application for a new venture that will use voice readings from patients, uploaded into the cloud securely, for which an AI algorithm is applied that will provide information regarding the presence, severity of Parkinson's disease. Our project aims at helping Parkinson's Disease Tech to define and develop its product. Also discover potential business problems and find out solutions.

The project is divided into four main parts:

1. The statement of work: This part first discusses the current Parkinson disease diagnosis industry and finds out one main issue is that there are huge demands for online diagnosis. Thus, we define the project objective which is going to develop an application that can improve the experience of remote diagnosis for patients with Parkinson's disease.
2. The system analysis: In this section we first construct the logical data flow diagrams for the whole project and then split it into different data flow diagrams for each process. The detailed descriptions of input and output for each process are also provided.
3. Product physical design: In this part we transform DFD from the logical design into the physical design. Then we conduct analysis for three candidate systems and apply feasibility analysis to rank all alternative systems to find out the best one. Lastly, we design some sample visualizations for input and output.
4. Implementation plan: The detailed implementation and the timeline are discussed in this part. The four main test cases are shown and the success criteria for the operation are defined. Finally, we retrospect the whole project and analyze the lessons learned from this project.

Candidate Solution Choice:

After evaluating technical, economic and organizational aspects, we decide to construct the application in house because it has better flexibility than other options.

Timeline: The project will start from May 2021 and last for two months.

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The Statement of Work (Approved by Clients)

Industry and background

Artificial intelligence has found numerous applications in diagnostics, monitoring and management of Parkinson Diagnosis. Recently, there are some other startup companies such as Canary Speech that also seek to use voice data to identify human conditions. While most of the applications are still in progress, we believe it will lead a new market and bring value to patients, community, and medical research.

Research shows that 89% of patients with Parkinson's disease (PD) experience speech disorders. Our client Parkinson's Disease Tech (PDT) is a stealth startup company that doesn't have any existing IT infrastructure yet. PDT is seeking to research and develop an application that reads and cloud stores Parkinson patients' voice data and applies AI algorithms in order to output Diagnostic information of Parkinson's disease. In other words, PDT aims to develop its first software application for AI diagnosis and therapy using voice patterns. The application diagnoses specific problems (e.g. early detection of Parksinon's disease) and there are a set of exercises related to those problems to improve the condition of patients (not traditional treatments). AI algorithms will be built and the model will be trained in collaboration with the George Washington University speech pathology department and other IT partners.

Strategic Issues being confronted with implementing artificial intelligence to the healthcare industry are intrinsic to the science of machine learning, such as requirement of large data set to train model, uncertainty about accuracy. The application also needs to be constantly monitored to be able to improve the performance and should be well integrated with clinical workflows.

Project Opportunities

We target the pain point that Parkinson's disease is hard to discover at the early stage while earlier diagnosis is crucial for treatment. Besides, it's inconvenient to meet with a doctor to make a diagnosis during special conditions (covid quarantine etc). Therefore, a remote method for patients to self-test is needed. Additionally, there are few methods to monitor the real-time symptom of Parkinson, so our project will have good application prospects. Our R&D process needs to follow FDA clinical trials, IRB rules, and HIPAA regulation.

The need to support tailored therapy is part of the opportunity. The Parkinson's Disease Drugs Industry predicts a 11.3% CAGR for the Global Parkinson's disease market during 2020 - 2027 and a market value of over 4,764.3 million US dollars by 2027. In 2017, the global market size for occupational and speech therapists was $58.4 billion, with North America ranking first in regional market size, consisting of 47.8% share of the global market.

Project Scope

We are going to design and analyze a Parkinson Diagnosis program easily accessible by patients. The main function of the application is to diagnose Parkinson's disease by the patient's preference of methods, and give recommendations about relative therapy exercises based on the diagnosis result.

The system is designed to have multiple user types. Besides regular users (patients), clinicians and caregivers will also benefit from the program. The diagnosis report generated from the program will be accessible by clinicians, which will help them monitor/track the condition of patients, and probably make adjustments in medication. The program will also advise the patients in therapies to take, which could be a good resource for caregivers.

In order to complete the diagnosis process, we will provide users with a variety of options. For example, by capturing the user's response to the requested action, movement or trembling. Other options could be asking the user to answer some testing questions or read a script to collect voice information, or getting permission to the mobile phone's microphone to collect the voice data. After collecting, all the data will be analyzed and uploaded to the cloud with encryption, and finally through the UI, testing results and treatment tips will be given to the user. Also, the diagnostic data will be open to the clinical team for further analysis.

Network security and user privacy will be important considerations for us. To strengthen the privacy, the captured data can be stored locally, and being encrypted before uploading. Since our users will be mainly older people, we will pursue a user-friendly interface design. The parts related to algorithms, AI training and software development will not be included in our plan. We will design the principal data requirements for the system, create different ways of data flows across the components of the system (data flow diagram), Entity Relationship diagram, and also description of the analysis and the choice we made for the system.

Project Objectives

The project objectives are in line with the business vision and goal. The business vision is to be the unmatched leader in improving the experience of remote diagnosis for patients with Parkinson's disease. The business goal is to public a voice diagnosis program with high accuracy, great privacy protection, and user-friendly interface. A visit to hospital or clinics is recommended after disease intendency suggested by the diagnosis of the application.

Constraints

Elderly people unfamiliar with mobile devices or the internet might not know how to use the application and make a test on their phones. Meanwhile, many elderly patients live alone or live in the nursing home so they cannot get help from their family to assist them to take a test. It can be an obstacle for our target users to use this application. The next constraint would be the potential misdiagnosis. Algorithms cannot promise one hundred percent accuracy for test results. A visit to hospital or clinics is recommended if the user gets a probability suggesting the disease after diagnosis from the application. Data storage and user privacy could be another problem, many people are not willing to store their medical data online because their data will be out of control and they are afraid of the company to use these data inappropriately.

Potential Solutions

Firstly, the company will provide the user guideline to help them to understand how to use the application and how to make a test. The guideline is consisting of video introduction and photo instruction. Both ways would assist users to use this application step by step. On the other hand, the user interface will be friendly to elders. The functions will be concise and simple for elders to use. If users still feel confused about how to use the application. They can use the online customer service and talk to representatives. As we mentioned before, no matter how advanced AI technology is, it still has a chance to make mistakes so the test result can only be a medical suggestion. However, the accuracy of the health test result is crucial for everyone. Lastly, the patient's data will be stored on their own devices instead of storing on the company's server, so patients don't need to worry about their privacy. The application will ask users to give permission to access medical data in their devices.

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Work breakdown structure and a Gantt Chart

1. PDT Project Plan - Software Architecture for AI Diagnosis and Therapy
    1.1 Statement of Work (SOW) [02/18/2021]
        1.1.1 Company and Industry Background Research -- Fengyi Zhao
        1.1.2 Kickoff Meeting with Project Sponsor -- Zhuxuan Xu
        1.1.3 Identify Problems, Opportunities, and Directives -- Xiang Gao
        1.1.4 Define Project Scope, Objectives, and Constraints --Jiangkun Xiong
        1.1.5 Initial Project Presentation -- Team
    1.2 System Analysis Report [04/10/2021]
        1.2.1 Describe Fact Findings and Information Gathering Techniques -- Fengyi Zhao, Xiang Gao
        1.2.2 Build System Models -- Zhuxuan Xu
            1.2.2.1 Create Data Flow Diagram (DFDs) -- Jin Sun
                1.2.2.1.1 Describe Input, Output, and Nature of Each Process
                1.2.2.1.2 Produce Error Reports
            1.2.2.2 Create Entity Relationship Diagrams (ERD) -- Team
    1.3 Design Phase Report [04/28/2021]
        1.3.1 Proposed System Design --Zhuxuan Xu
            1.3.1.1 Correct DFDs and ERD as Needed
            1.3.1.2 Build Synchronized System Models (CRUD Matrix)
        1.3.2 Physical System Design -- Jiangkun Xiong, Xiang Gao
            1.3.2.1 Create Candidate System Solutions Table
            1.3.2.2 Apply Feasibility Analysis Matrix
            1.3.2.3 Create Physical DFDs
        1.3.3 Input and Output Design -- Jin Sun, Fengyi
            1.3.3.1 Provide Four Samples of Input
            1.3.3.2 Provide Four Samples of Output
        1.3.4 Plan Implementation -- Team
        1.3.5 Summarize and Conclude -- Team
    1.4 Project Audit and Final Presentation -- Team [04/28/2021]

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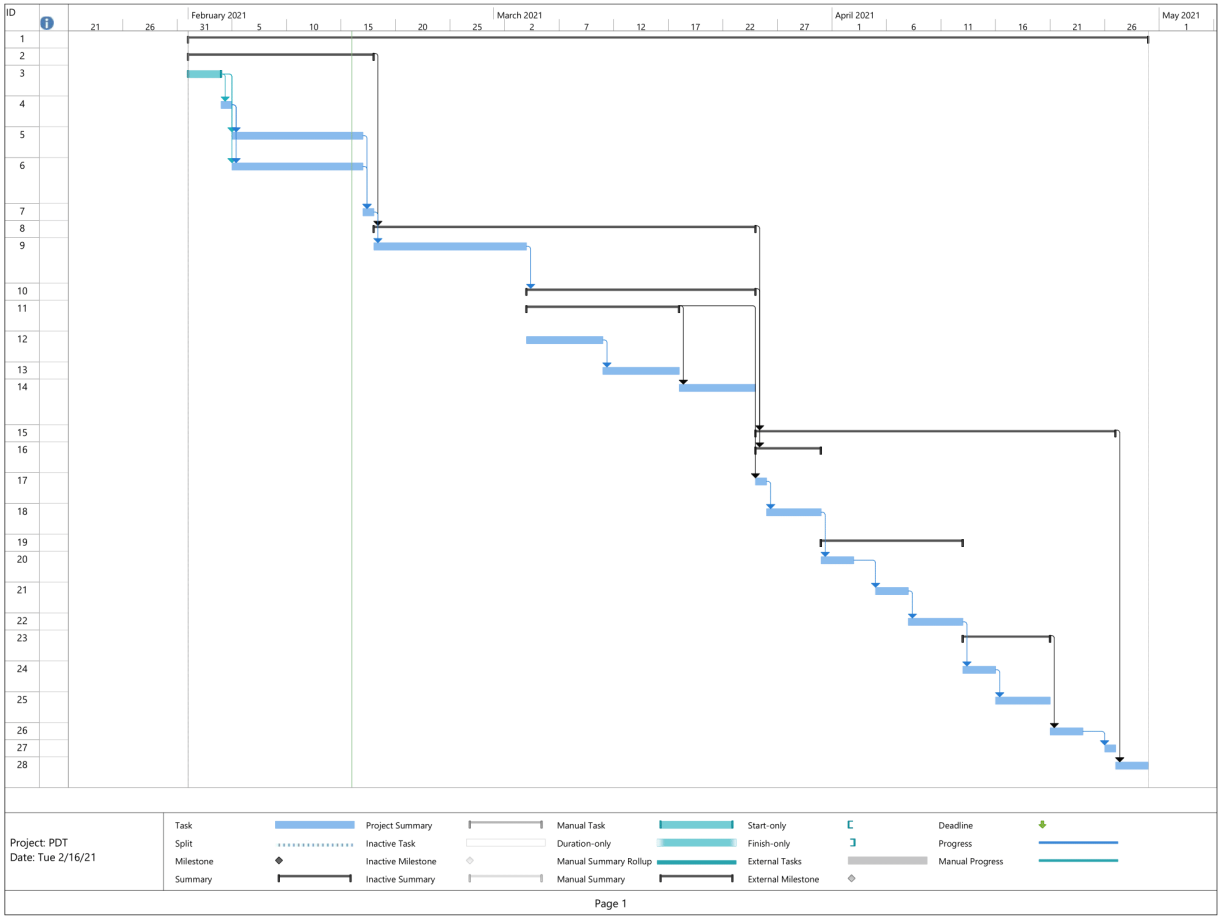
Gantt Chart:



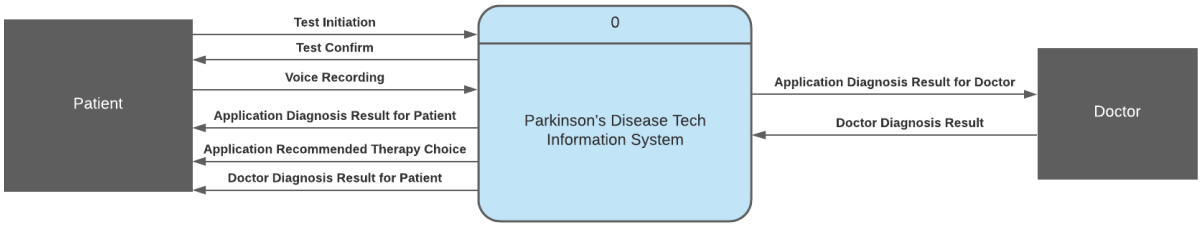
Note: the schedule is subject to change in the future.

Fact Findings and Information Gathering Techniques

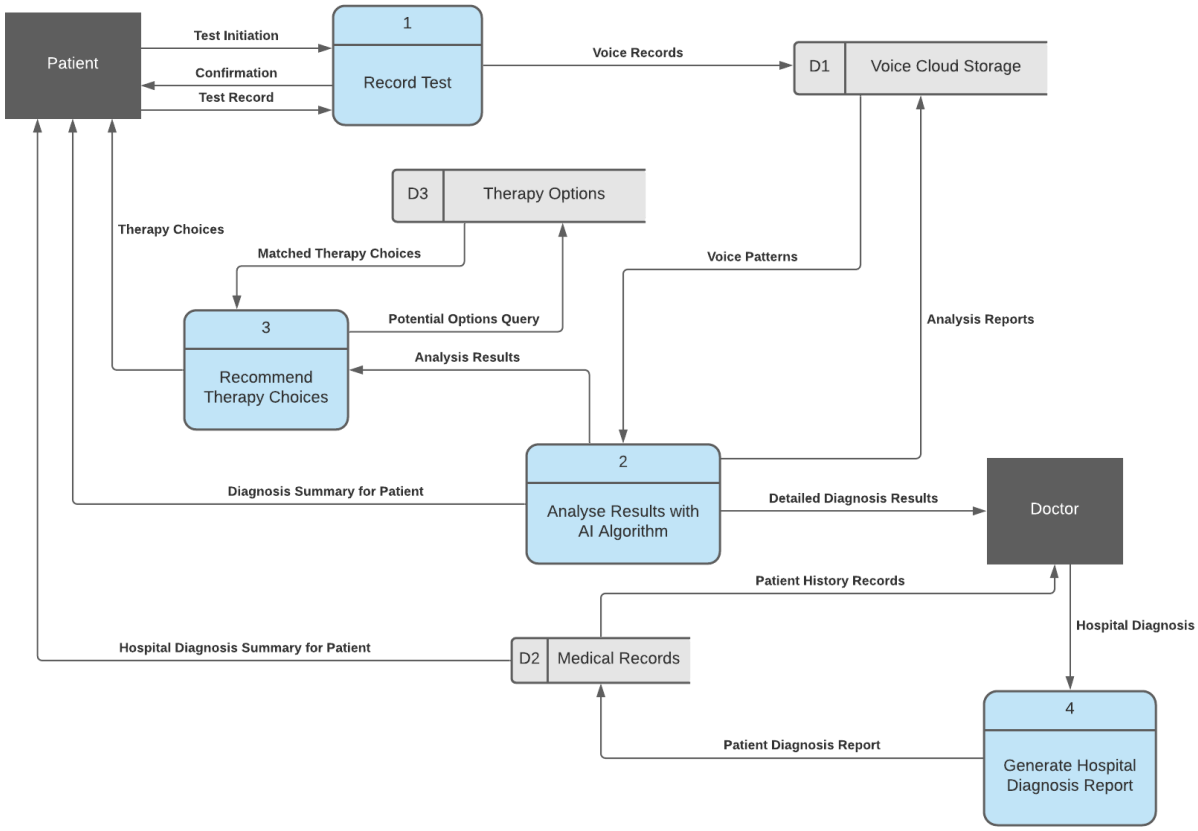
To know more details about the current system, we gathered information mainly through conducting interviews, discussion meetings and workflow assessment. After our first meeting with our client, we researched thoroughly about the AI for Parkinson Disease in the current market and defined the scope of the system and its objective. Then we studied the flow of data in our system and summarized them by using the form of DFDs and ERD. We then presented the flow charts to our client so that he can understand the system and talk about feasibility. We also made a list of sample inputs and outputs containing information and got contents approved by our client through submitting the revision of the Statement of work. Later next step we will analyze the requirements and reports from the implementation point of view, and write a system manual for users. Also, to make our research more realistic, we have made a review of healthcare data standards and security requirements as part of our data gathering process.

System Models - Logical Data Flow Diagrams (DFDs)

DFD Context Diagram



DFD Level 0 Diagram



DFD Level 0 Description

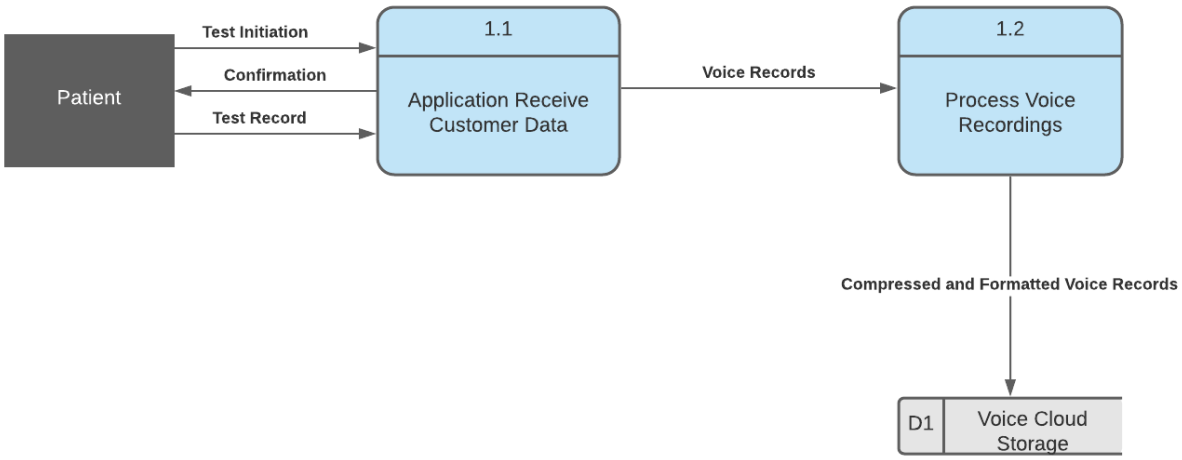
Use Case Name: **Record Test**		ID: UC-1	Priority: High
Actor: Patient			
Description: The use case describes how the customer initiates a test and then the application records a test made by a patient. The record will be stored in the cloud database.			
Trigger: The application sends the test request to patient			
Type: External			
Summary Inputs	Source	Outputs	Destination
Test Initiation Test Record	Patient Patient	Confirmation Test Record	Patient Voice cloud data storage

Use Case Name: **Analyze results with AI Algorithm**		ID: UC-2	Priority: High
Actor: Doctor			
Description: The use case describes how the doctor receives patient's diagnosis results from the application			
Trigger: The application receives test records and transform them into detailed diagnosis results			
Type: External			
Summary Inputs	Source	Outputs	Destination
Voice patterns	Voice cloud storage	Analysis reports Analysis results Diagnosis summary Detailed diagnosis results	Voice cloud storage Therapy system Patient Doctor

Use Case Name: **Recommend therapy choices**		ID: UC-3	Priority: High
Actor: Patient			
Description: This use case describes how patients receive their recommended therapy choices.			
Trigger: The therapy system receives the analysis result then generate therapy choices			
Type: External			
Summary Inputs	Source	Outputs	Destination
Analysis results Matched therapy choices	Analysis system Therapy options storage	Potential options query Therapy choices	Therapy options storage Patient

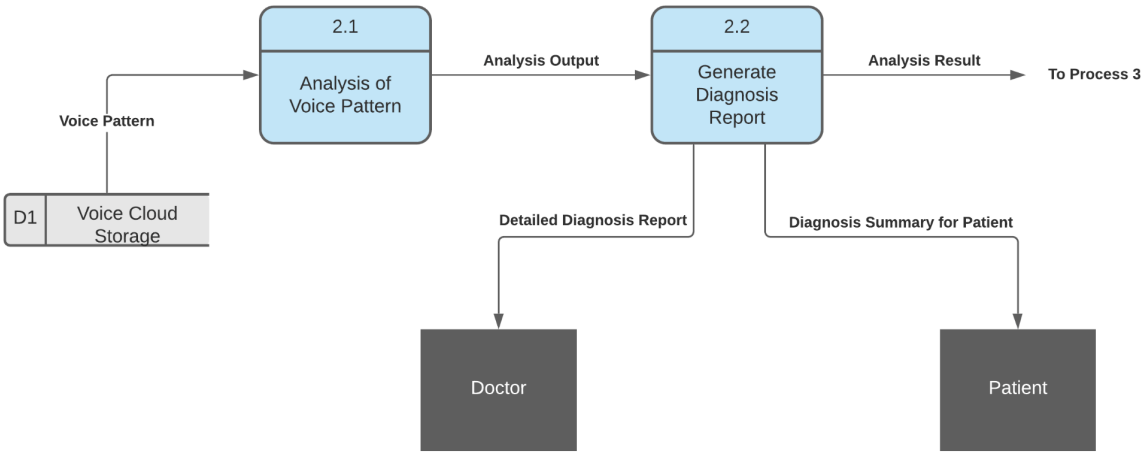
Use Case Name: **Generate hospital diagnosis report**		ID: UC-4	Priority: High
Actor: Doctor			
Description: This use case describes doctor generate diagnosis report for patients			
Trigger: Doctors refer results generated by AI and then generate hospital diagnosis report			
Type: External			
Summary Inputs	Source	Outputs	Destination
Hospital diagnosis	Doctor	Patient diagnosis report	Medical records storage

DFD Level 1 Diagram - Process 1



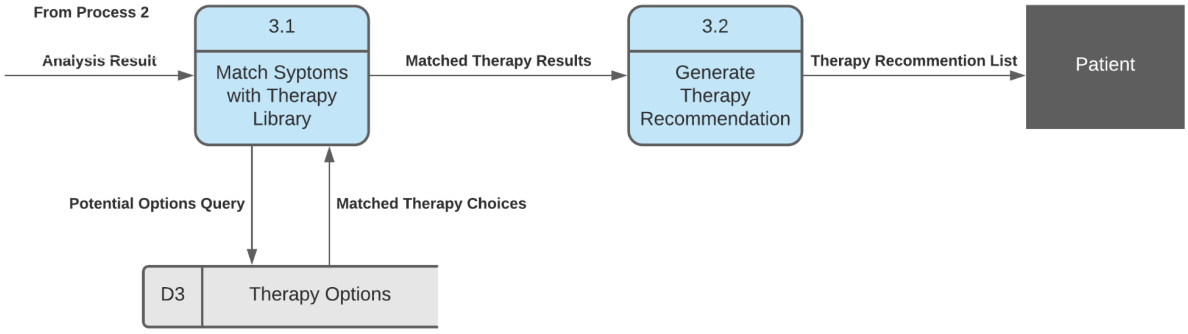
Description: First of all, the patient will initiate a test requirement and send it to the application. Once the application receives the requirement, it will send the confirmation message back to the patient and then the patient will respond with the test record. These responses will be stored as voice records and be processed to become formatted records. After that, these data will be stored in the voice cloud dataset.

DFD Level 1 Diagram - Process 2



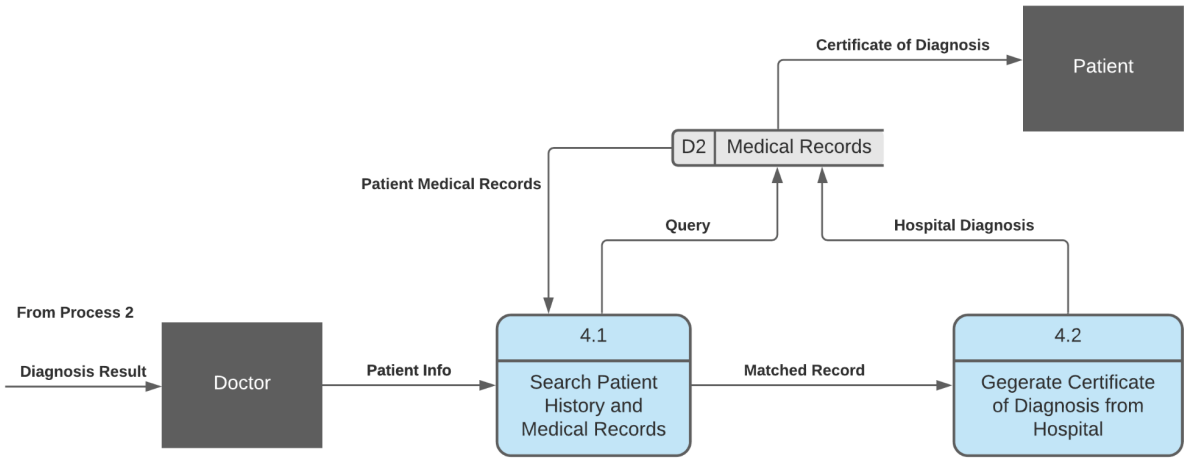
Description: First of all, the voice cloud dataset will send voice records to the application and these records will be analyzed by AI technology. The application can generate diagnosis results and reports. Then these reports will be sent to either doctors or patients. Also the analysis results will be sent to process 3.

DFD Level 1 Diagram - Process 3



Description: First of all, this process will receive analysis results from process 2 and generate potential options query. Then the system will send the query to therapy options dataset and the dataset will return matched therapy choices. Next the application can generate therapy recommendation lists to patients.

DFD Level 1 Diagram - Process 4



Description: First of all, doctors will receive diagnosis results that are generated from process 2. Then doctors will enter patients' information into the system and search their medical records. If patients' have historical records, doctors can get the records from a medical records dataset. Then these medical records will be generated into final certificated results and be sent to patients.

DFDs Evaluation

DFD Error Checking Report	
Within DFD	
Process	● Every process was checked to have a unique name that is an action-oriented verb phrase, a number, and a description. ● Every process was checked to have at least one input and one output data flow. ● Every output data flow was checked to have a different name than input data flow. ● Each DFD was checked to have between two and seven processes.
Data Flow	● Every data flow was checked to have a unique name that is a noun, and a description. ● Every data flow was checked to connect to at least one process. ● Every data flow was checked to have only one direction. ● No crossing of data flow lines in the graph.
Data Store	● Every data store was checked to have a unique name that is a noun and a description. ● Every data store was checked to have at least one input data flow and at least one output data flow on some page of the process model.
External Entity	● Every external entity was checked to have a unique name that is a noun, and a description. ● Every external entity was checked to have at least one input or output data flow.
Across DFDs	
Context diagram	● One context diagram was created for a set of DFDs.
Viewpoint	● Viewpoint for the entire set of DFDs was consistent.
Decomposition	● Every process in level 0 was wholly and completely described by the processes on its children DFDs in level 1.
Balance	● Every data flow, data store, and external entity on a higher level DFD was shown on the lower-level DFD that decomposes it.

Semantics	
Appropriate Representation	● Users of Parkinson's Disease Tech Information System were validated in DFDs. ● Every process was checked by the role-play procedure.
Consistent Decomposition	● Lowest-level DFD was checked to decompose into the higher level DFD consistently.
Consistent Terminology	● Terminologies and names were examined carefully.

DFDs evaluation conclusion: after evaluating all DFDs through the error checking procedure, we are confident that the designed logical DFDs have good quality without any syntax error and semantic error.

System Models - Entity Relationship Diagrams (ERD)

Our client, Parkinson's Disease Tech (PDT) managed its database system by storing the information in a number of entities listed below:

- Companion - help the patient who has difficulties in using the mobile device operate the application. Companion is usually the patient's spouse or child.
- Patient - store the required details about the patient.
- Voice Recording - store the recording voice when the patient takes a test.
- App Diagnosis - diagnosis report produced by the application.
- Therapy Recommendations - recommended therapy lists for the patient based on an application diagnosis result.
- Doctor - stores the required details about the doctor.
- Hospital Diagnosis - diagnosis report authenticated by the doctor.

Relationships between entities:

- One patient can only be assisted by zero or one companion, one companion can assist one or more patients.
- One patient can produce zero or more voice recordings, one voice recording can only be produced by one and only one patient.
- One app diagnosis can be output by one or more voice recordings, one voice recording can only output one app diagnosis.
- One app diagnosis can only be delivered to zero or one doctor, one doctor can be delivered with zero or more app diagnosis.
- One doctor can generate zero or more hospital diagnosis reports, one hospital diagnosis report can be generated by one and only one doctor.
- One patient can be given zero or more hospital diagnosis reports, one hospital diagnosis report can give to one and only one patient.
- One app diagnosis report can recommend one or more therapy options, one therapy option is recommended by one and only one app diagnosis report.
- One patient can be given zero or many therapy recommendations, one therapy recommendation can give to one and only one patient.

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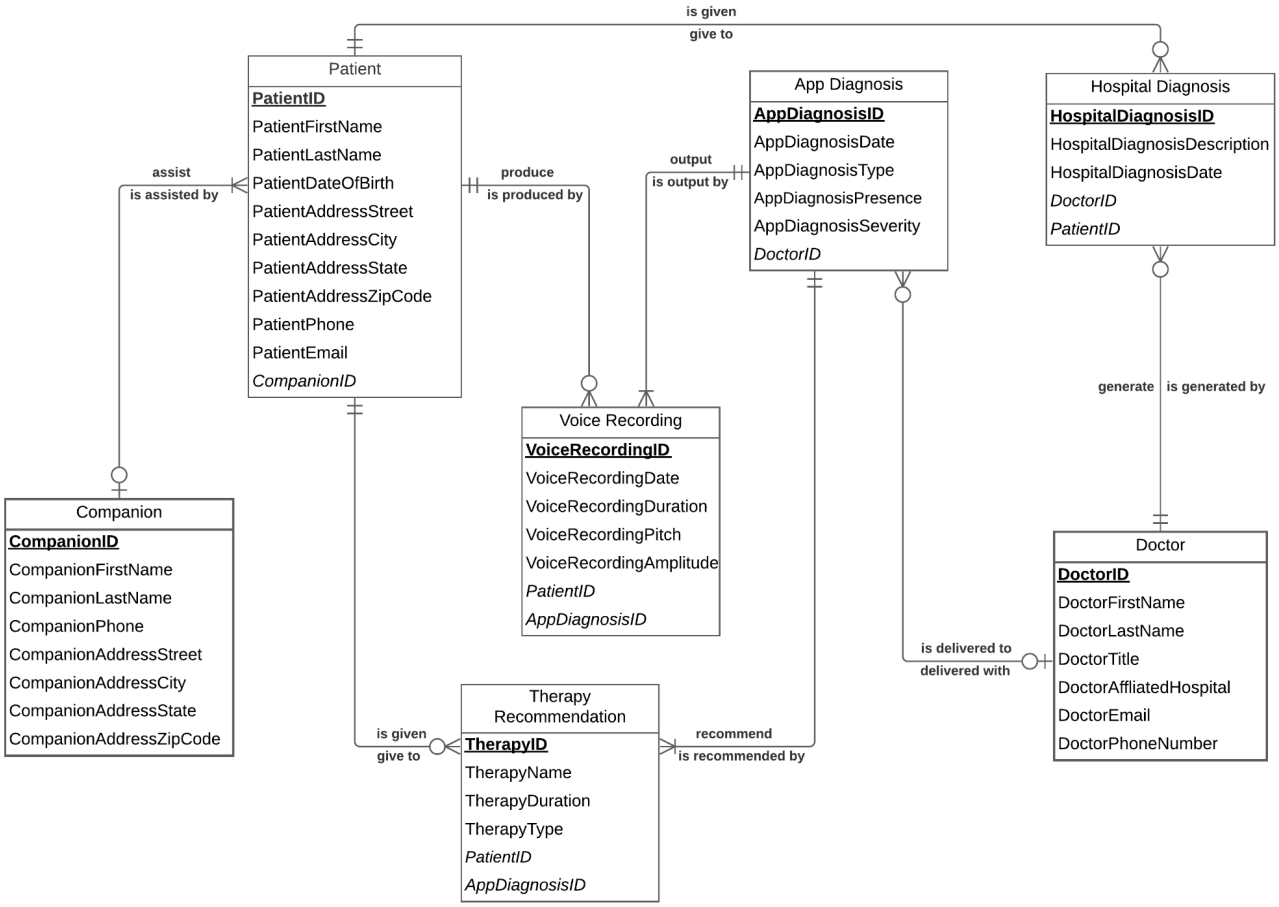


The CRUD Matrix

The DFD data components need to balance with the ERD's data entities and attributes. So the CRUD (create, read, update, delete) Matrix is developed on the basis of the logical process and data models, to verify that every attribute is created, read, updated, and deleted somewhere in the process model.

	Process 1 - Record test	**Process 2 - Analyse Results with AI Algorithm**	**Process 3 - Recommend Therapy Choices**	**Process 4 - Generate Hospital Diagnosis Report**
Data Entity Companion				
Attribute CompanionID	CRUD			
Attribute CompanionFirstName	CRUD			
Attribute CompanionLastName	CRUD			
Attribute CompanionPhone	CRUD			
Attribute CompanionAddressStreet	CRUD			
Attribute CompanionAddressCity	CRUD			
Attribute CompanionAddressState	CRUD			
Attribute CompanionAddressZipCode	CRUD			
Data Entity Patient				
Attribute PatientID	CRUD	R	R	R
Attribute PatientFirstName	CRUD	R	R	R
Attribute PatientLastName	CRUD	R	R	R
Attribute PatientDateOfBirth	CRUD	R	R	R
Attribute PatientAddressStreet	CRUD	R	R	R
Attribute PatientAddressCity	CRUD	R	R	R

Attribute PatientAddressState	CRUD	R	R	R
Attribute PatientAddressZipCode	CRUD	R	R	R
Attribute PatientPhone	CRUD	R	R	R
Attribute PatientEmail	CRUD	R	R	R
Data Entity Voice Recording				
Attribute VoiceRecordingID	CRUD	R		
Attribute VoiceRecordingDate	CRUD	R		
Attribute VoiceRecordingDuration	CRUD	R		
Attribute VoiceRecordingPitch	CRUD	R		
Attribute VoiceRecordingAmp	CRUD	R		
Data Entity App Diagnosis				
Attribute AppDiagnosisID		CRUD	R	R
Attribute AppDiagnosisDate		CRUD	R	R
Attribute AppDiagnosisType		CRUD	R	R
Attribute AppDiagnosisPresence		CRUD	R	R
Attribute AppDiagnosisSeverity		CRUD	R	R
Data Entity Therapy Recommendation				
Attribute TherapyID			CRUD	
Attribute TherapyName			CRUD	
Attribute TherapyDuration			CRUD	
Attribute TherapyType			CRUD	

Data Entity Doctor				
Attribute DoctorID				CRUD
Attribute DoctorFirstName				CRUD
Attribute DoctorLastName				CRUD
Attribute DoctorTitle				CRUD
Attribute DoctorAffiliatedHospital				CRUD
Attribute DoctorEmail				CRUD
Attribute DoctorPhoneNumber				CRUD
Data Entity Hospital Diagnosis				
Attribute HospitalDiagnosisID				CRUD
Attribute HospitalDiagnosisDesc				CRUD
Attribute HospitalDiagnosisDate				CRUD

The Candidate System Solutions Table

Description of Candidates:

1. **Nuance -** a subsidiary service of Microsoft, uses cloud-based secure speech recognition and transcription to accurately and efficiently capture patient information across all major EHR platforms. The comprehensive product portfolio of AI-based cloud-based solutions is designed to efficiently and effectively improve documentation to promote excellent clinical documentation throughout the entire care process.
2. **Aculab Cloud -** Aculab Cloud uses algorithms to analyze the movement of the vocal cords in the phone, and then detects changes in the human voice to help clinicians score symptoms (such as Parkinson's disease). It can help manage certain disorders and diseases that affect speech.
3. **Parkinson's Disease Tech in-house Solution -** Parkinson's Disease Tech focuses on the recording and analysis of patients' daily lives. The main function of the application is to diagnose and analyze Parkinson's disease based on the behavior of the patient in daily life, and to give suggestions on relative therapy exercises based on the diagnosis results and the medical team.

Characteristics	**Candidate 1** **(COTS: Nuance)**	**Candidate 2** **(COTS: Aculab Cloud)**	**Candidate 3** **(Custom Solution)**
Portion of System Computerized	Voice detection recognition and personalized clinical documentation will be computerized with Nuance's COTS package.	Voice detection recognition, with COTS system from Aculab Cloud.	Same portion of system as Candidate 1, but with a custom solution.
Benefits	With this solution, it will become more convenient to capture clinically relevant data. The record of medical documents will also be integrated in the system, and Nuance is compatible with all advanced EHRs.	Voice analysis platform, cloud-based complete functions, using algorithms to analyze the movement of the vocal cords in the phone, and score Parkinson's symptoms.	Creates the most user-friendly interface that helps with elder people processes and corporate with the medical system. Customers will feel convenient to receive treatment for Parkinson's disease from this custom-built system eventually.
Servers and Workstations	Compatible with Windows laptops/PC/tablets.	Aculab Cloud platform	Servers and workstations: PC w/ modem ISP contract
Software Tools Needed	Web browser (Supported browsers: Chrome, Safari, Firefox, Microsoft Edge)	VoiScan	Mysql HTML PHP CSS JavaScript

Application Software	Nuance Platform; Supported operating system: Windows; Javascript must be enabled to edit the Nuance site.	VoiScan Powered by Aculab Cloud; Supported operating system; Javascript must be enabled to edit the site.	Operating systems will be preinstalled on the hardware purchased. Database software to be purchased is MS Access
Method of Data Processing	Catching voice, and speech recognition: Cloud based. Client request: Remote Batch	Catching voice, and speech recognition: Cloud based. Client request: Remote Batch	Catching voice, and speech recognition: Cloud based. Client request: Remote Batch
Output Devices and Implications	PC monitor	Monitor Phone	Monitor
Input Devices and Implications	Keyboard and mouse, Microphone	Keyboard and Mouse, Microphone	Keyboard and Mouse, Microphone
Storage Devices and Implications	All data (voice gathered, EHR, etc.) will be stored in Nuance's cloud server.	All data (voice gathered, etc.) will be stored in the Aculab's cloud server.	Analysis data will be encrypted and uploaded to the cloud. Audio data will be stored locally

Feasibility Analysis Matrix

Evaluation Criteria	Relative Importance	Alternative 1:**Nuance**	Score (1-5)	Weighted Score	Alternative 2: **Aculab cloud**	Score(1-5)	Weighted Score	Alternative 3:**Make in house**	Score (1-5)	Weighted Score
Technical Issues:	40									
Develop desirable in-house skills	15	Developed in Javascript;would like to develop in-house Javascript skills	5	75	Developed in Javascript; would like to develop in-house Javascript skills	5	75	Developed in Javascript; would like to develop in-house Javascript skills	5	75
Data and system security skills	15	Employees receive related trainings and passed security exams	5	75	Employees receive related trainings and passed security exams	5	75	Employees receive related trainings and passed security exams	5	75
Experience with product	10	Already designed similar products	5	50	Already designed similar products	3	30	Less experience with product	2	20
Economic Issues:	15									
Cost	15	$6,000	2	30	$4,000	3	45	$7,000	1	15
Organizational Issues:	45									
Demonstrated product in market	15	Program used by other companies	4	60	Program used by other companies	3	45	Brand-new product	2	40
Customizable interface	30	No	1	30	Yes, but not easy	2	60	Yes, easy to do	4	120
Total	100			325			330			340

Rationale for weights:

We rank the elements of feasibility in the following order:

1. **Technical feasibility: 40%**

   This is the basic factor in the project proposal, because we must ensure that the proposed technology is suitable for the patient's diagnosis process and is mature, and that the participants have the expertise to use these technologies.

2. **Economic Feasibility: 15%**

   Business owners did not excessively restrict the investment in the project, and they paid more attention to technical and organizational feasibility. They want a fully functional and well-performing system without worrying too much about overhead.

3. **Organizational feasibility: 45%**

   This feasibility has the highest weight in feasibility, because the main measure of this project is whether the new system can provide customers with a better experience in future operations. We want the system to actually operate normally and maximize user-friendliness.

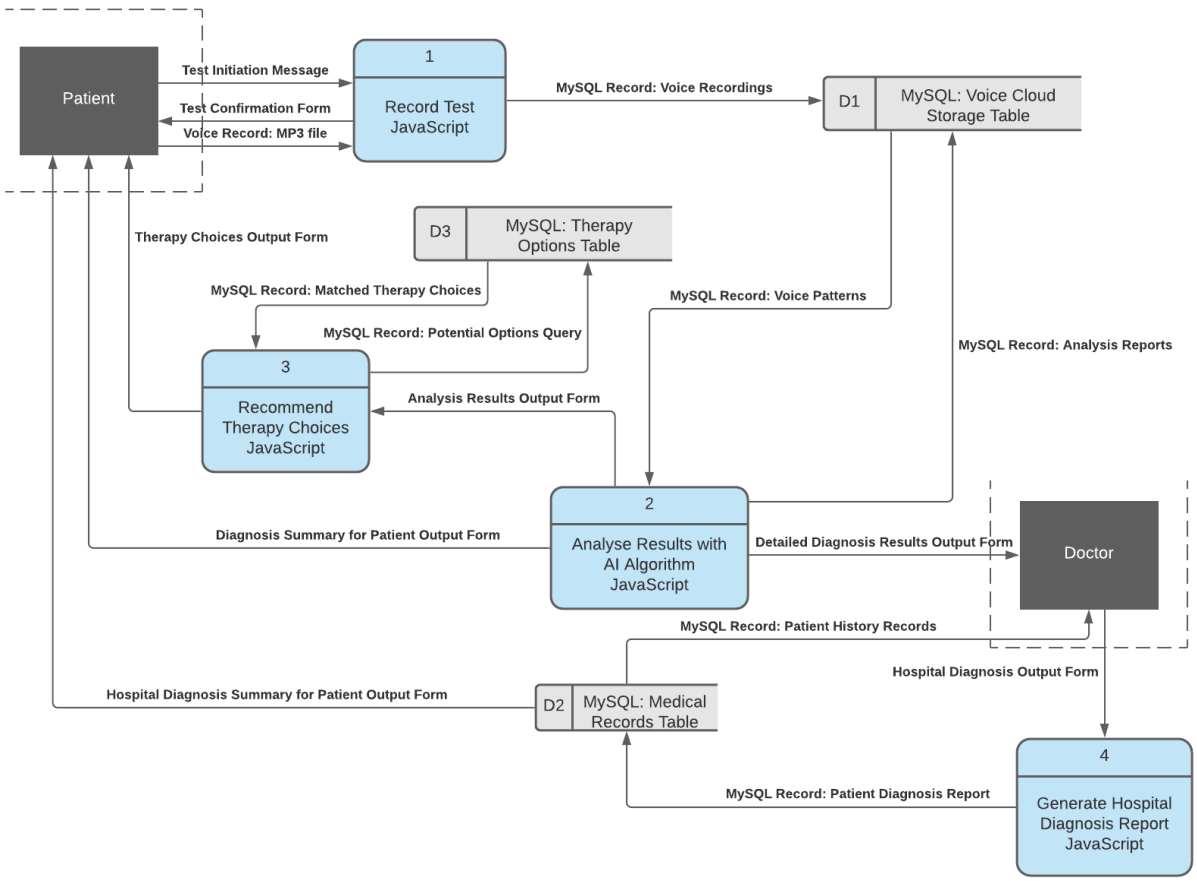
Based on the feasibility analysis matrix, we decided to make the system in house for two main reasons: 1) benefit of flexibility for customizable interfaces and 2) developing desirable in-house skills.

Although PDT does not have relative experience in delivering a new healthcare programming product, we are capable of developing and managing the new application. The application itself is also new to the market -- Nuance and Aculab Cloud do not have experience in developing products of the same kind. We believe that the benefit of in house development will compensate for the cost.

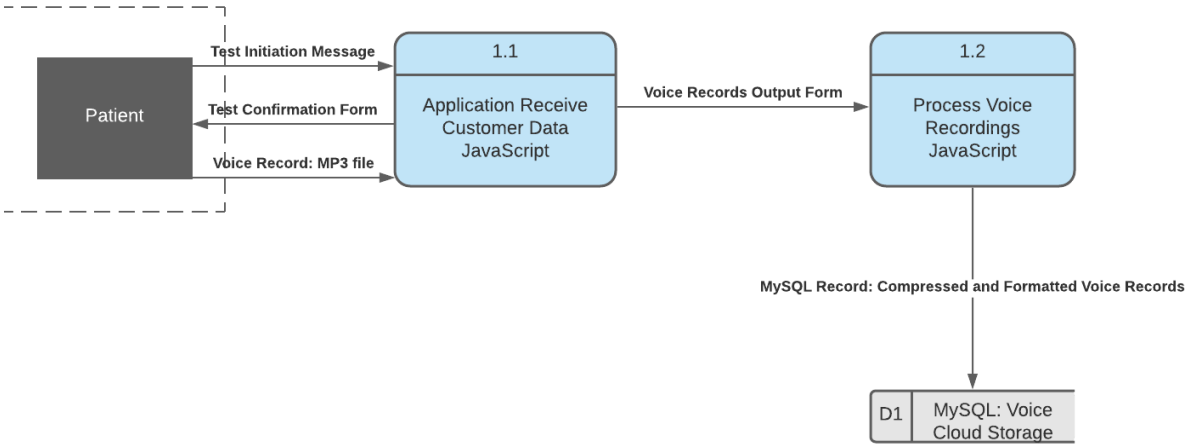
Physical DFDs

JavaScript was selected as the programming language to develop Parkinson's Disease Tech (PDT) mobile application, because the application will be launched at both Android and IOS platforms and we expect that a single development would work for multiple platforms. So programming languages for hybrid applications were under consideration. The most popular hybrid languages use JavaScript frameworks, and it is a general-purpose programming language for multiple use cases; MySQL was chosen to store the cloud data including voice recordings, medical records, and therapy options. Audio files can be stored as binary data and every relational database supports this data type. So MySQL is compatible with the voice data.

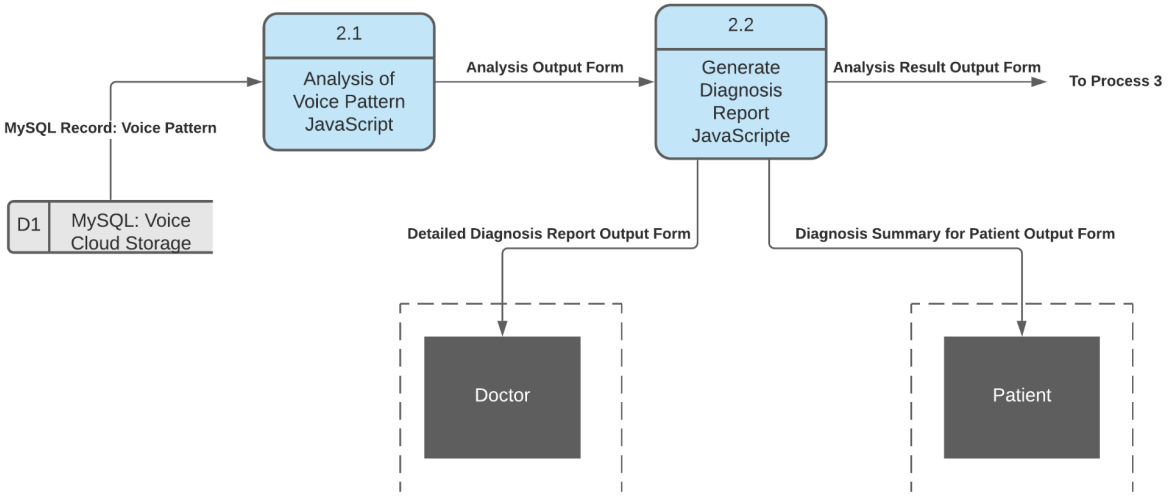
Physical DFD Level 0



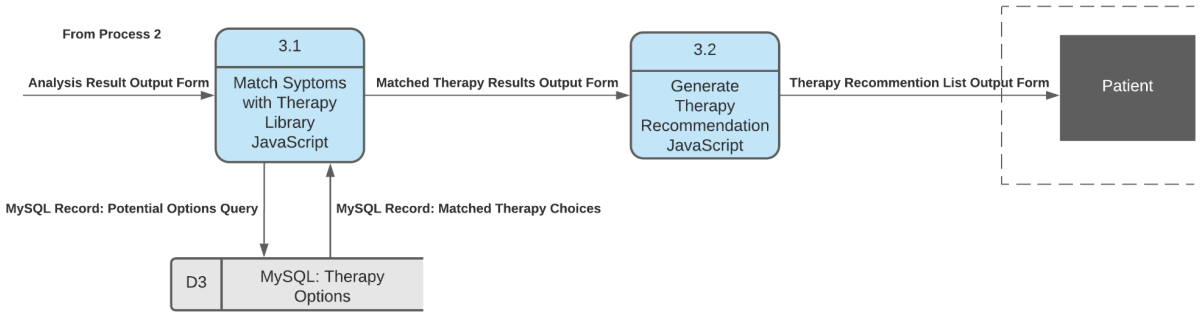
Physical DFD Level 1 - Process 1



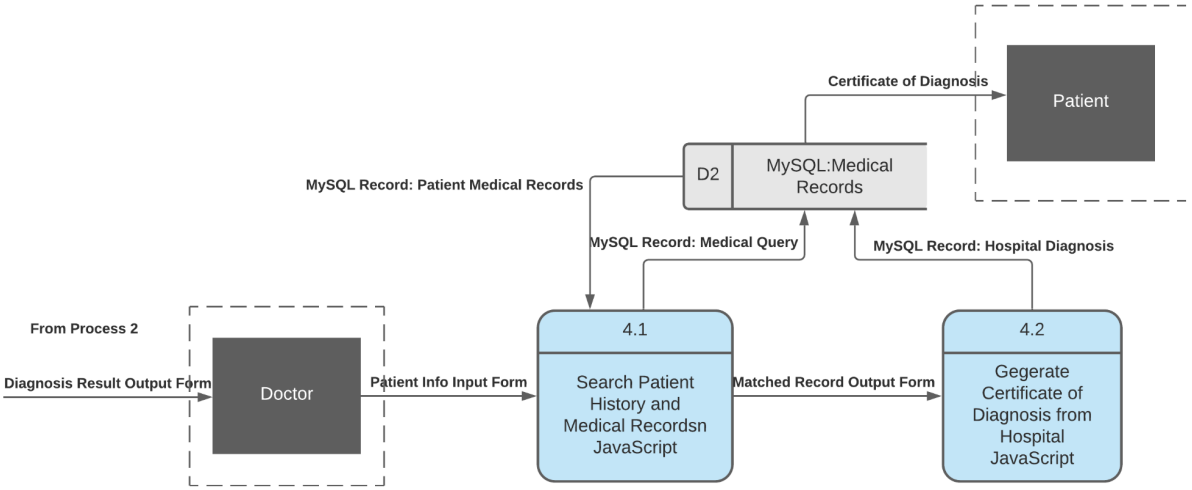
Physical DFD Level 1 - Process 2



Physical DFD Level 1 - Process 3



Physical DFD Level 1 - Process 4



Input and Output Design

The input design will connect the data input with user needs. Our design will focus on providing the right data to be collected and have clear description or instructions for users to understand. Figure 1- 4 demonstrates the user interface designs by each step.

Figure 1

Figure 2

Figure 3

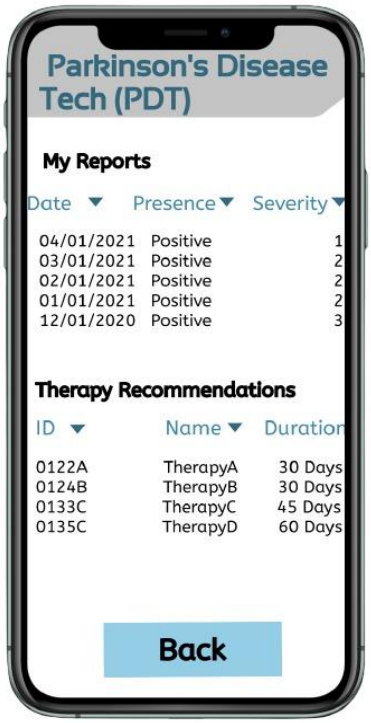


Figure 4

Figure 5

Figure 6

The patient user will choose whether to start a new test, check previous reports, or review therapy recommendations when the user launches the application (Figure 1). If the user needs to start a new test, he will be directed to a new page to start and submit a recording (Figure 2). The patient user will be able to view the output when he/she chooses to view previous reports or view therapy recommendations (Figure 3). To view by summary (Figure 4), the patient will be directed to a summary page of reports and therapies by date. The patient will also be able to filter the results based on certain parameters (i.e. presence, severity, etc). To view by Chart (Figure 5), the patient will see a graph of the tracking record of the severity and presence of Parkinson's disease. The patient will see therapy recommendations in detail after clicking a specific therapy on the list.

Doctors will be the other primary user for Parkinson's Disease Tech. The Doctors will be able to view a particular patient's diagnosis report by Parkinson's Disease Tech by entering the patient ID (Figure 7).

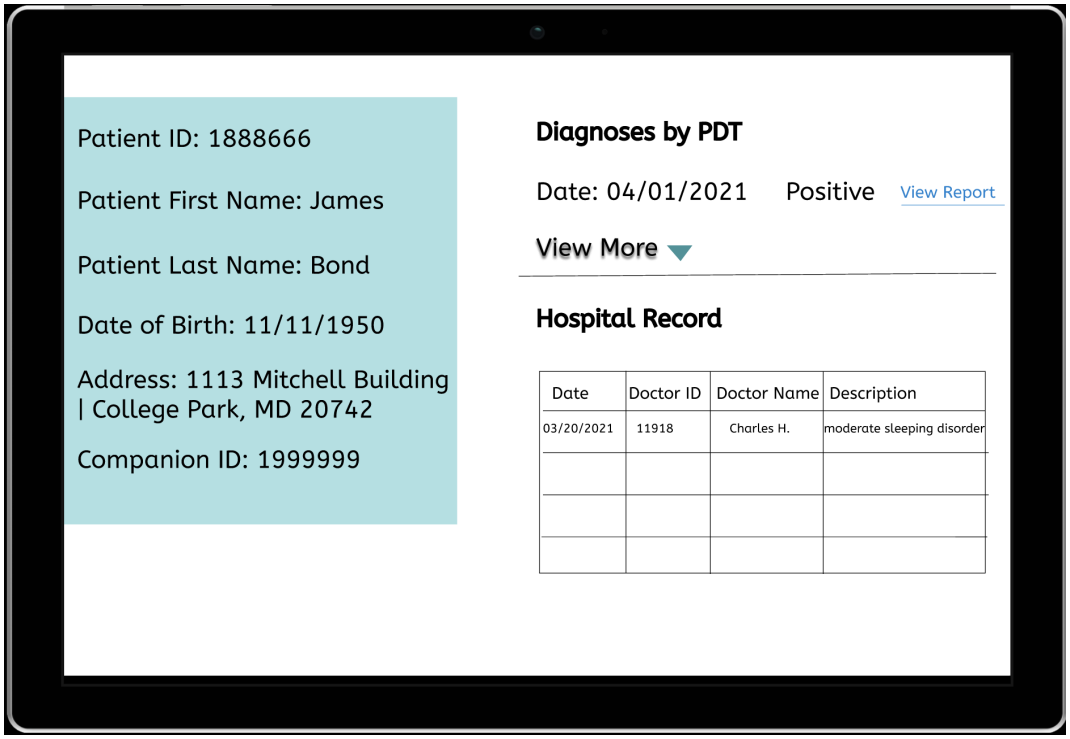


Figure 7

Doctors will make further diagnosis for Parkinson's disease based on the patient's medical history, the signs and symptoms of the patient indicated by the Parkinson's Disease Tech application (Figure 8), and a neurological and physical examination.

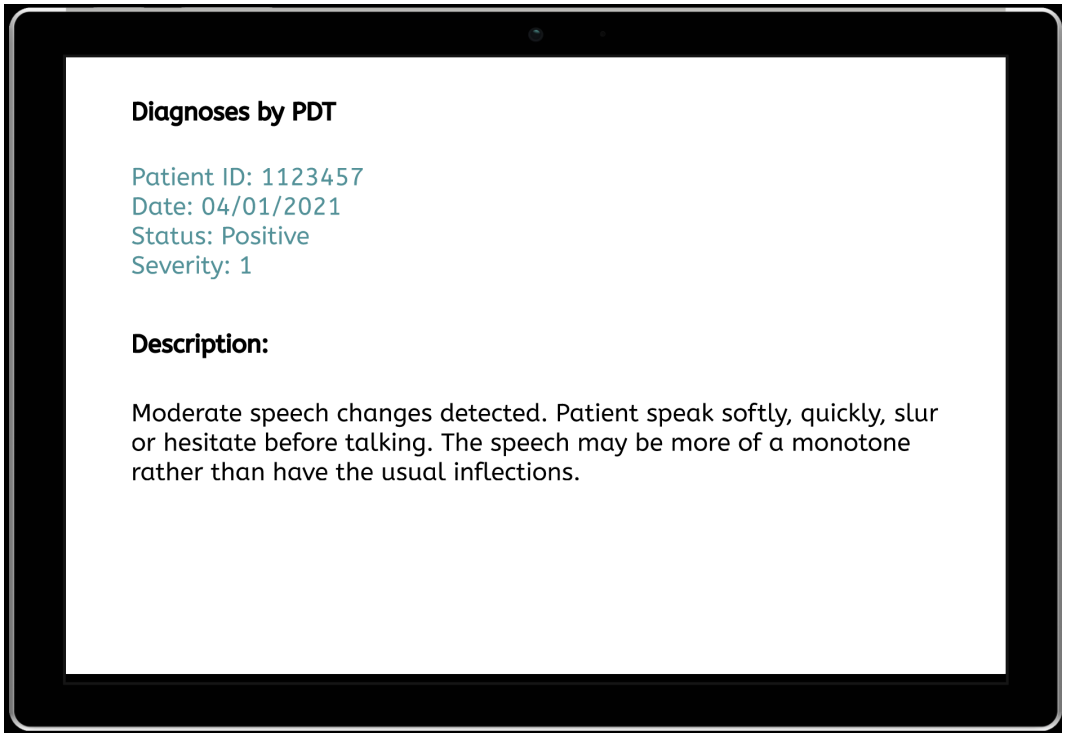


Figure 8

Implementation Plan

Our Implementation plan for Parkinson's Disease Tech includes human resources arrangement, suggested schedule of activities, test cases, and basic documentation. Below is the suggested schedule of activities. It will start with project plan finalization and a kickoff event, then the IT will design and install computer hardware and software to get ready for the system development. The development team will configure and integrate the system. The testing group will do the quality assessment and lastly there will be an adoption and training process for users and sponsors where all departments will participate. After the system goes live we would like to recommend lengthening the project with design and marketing steps.

Milestone	Start Date	Completion Date	Department
Project Plan Finalization, System Needs Discussion	05/10/2021	05/10/2020	All departments
Kickoff: Launch Event	05/11/2021	05/11/2021	All departments
Designing and Installing Computer Hardware Configurations	5/11/2021	5/11/2021	System Development (SD)
Build Software	5/12/2021	5/12/2021	SD, Project Management (PM)
Installing Software and Networking System	5/12/2021	5/20/2021	IT, PM
Configure and Integrate	5/20/2021	5/25/2021	IT, PM
Validate Configuration	5/25/2021	5/30/2021	IT, PM
QA Testing	5/30/2021	6/20/2021	Test, PM
User Adoption Process And Training	6/20/2021	6/25/2021	IT, PM
Post-Implementation Support and QA	6/25/2021	6/28/2021	PM
Channel Expansion: Recruit more specialists	06/28/2021	06/30/2021	Salesforce, HR

Television Commercials, hospital publicity, Home Visit	06/30/2021	07/04/2021	Marketing, Production, User Research
Research what marketing technique saw the greatest increase in download and use	07/04/2021	07/15/2021	R&D, Accounting/Finance, Data Analytics
Final Project Docking	07/15/2021	07/15/2021	All departments, Client

For the human resources arrangement, a team of eleven people will be formed. Three people are responsible for the overall project management, and five people for system development, and three for quality assurance and testing. In the future we want to ensure normal closure where we don't go over budget and to improve efficiency of the team so that we can hire members that can complete a large project like this within the schedule created. We plan to hire a more experienced project manager and have them communicate more with group members to see which tasks are most suited to which team members and which tasks can be performed in conjunction with others to save time. For future projects, a responsibility matrix is recommended as this will ensure that all team members know what tasks they are responsible for performing and supporting, while also helping the project manager keep track of what resources are needed for each phase of the project.

Below table shows their title and job responsibilities accordingly.

Team Project 4b: Fengyi Zhao, Jin Sun, Xiang Gao, Jiangkun Xiong, Zhuxuan Xu

Department	Staff	Job Responsibility	Number of People Assign
Project Management	IT Project Manager	Manages and oversees all aspects of a technology project to ensure it is completed on-time and within budget. Has overall responsibility for managing scope, cost, schedule, internal staffing and outside vendors, and contractual deliverable.	1
	IT Project Manager Assistant	Assist Project Manager in preparing reports for upper management regarding status of project. Possesses strong knowledge of technology. Reports to the Project Manager.	2
System Development	Application Systems Analyst	Researches, analyzes, and designs system applications to meet the needs of an organization and integrate with existing and future systems.	2
	Software Engineer	Designs and develops software applications. Performs coding, debugging, testing and troubleshooting throughout the application development process.	2
	Software Developer	Perform coding, debugging, testing and troubleshooting throughout the application development process.	1
Test	Quality Assurance Manager	Manages activities for the development team. Guide the conceptualization, requirement gathering, specification creation, release, and implementation processes.	1
	Software Quality Assurance Analyst	Executes testing procedures to ensure that software meets established quality standards. Prepares datasets to test logic, error handling and system workflows. Reports to Quality Assurance Manager.	2

Test Cases

We conducted four test scenarios according to the Level 1 processes. For process 1, we verify the patient is entering the right format of voice message and the expected result is that the patient sees a message that shows “recording successful”. For process 2, we verify the recording is converted, the expected value is the user seeing a message shows “Converted Successful”. For process 3, we verify the system is generating recommendation and report, and the expected value shall be that the patient should be able to access the recommendation created by the system. In process 4, we verified the doctor could receive the diagnosis report, and the expected value should be able to review the diagnosis repost by Parkinson Disease Tesch. Below shows the test cases according to Level 1 processes.

01	Verify patient is entering the right format of voice message	• **Prerequisite:** Patient should have the credential to login into the system • **Test Process:** Login into the system with patient role and click start recording/stop recording • **Test Data:** Patient ID, Password, voice recording	• **Expected Result: Patient should be able to see message “Your recording is successful”** • **Actual Result: Patient see “Try again”** • **Fail**
02	Verify the recording is converted	• **Prerequisite:** Voice recording have been uploaded; doctor have the credentials • **Test Process:** Login into the system with doctor role and access voice recordings • **Test Data:** voice recording	• **Expected Result: The recording is converted and shows a message of “Converted Successful”** • **Actual Result: The recording is converted and shows a message of “Converted Success”** • **Pass**
03	Verify the system is generating recommendation & report	• **Prerequisite:** Voice recording have been uploaded; AI have review the recording and send output • **Test Process:** Login into the system with patient role and access system recommendation and report • **Test Data:** voice recording	• **Expected Result: Patient should be able to access the system recommendation** • **Actual Result: Patient see “Your system recommendation is not ready yet, try again”** • **Fail**
04	Verify the doctor could receive the diagnosis report	• **Prerequisite:** Voice recording have been uploaded; doctor have the credentials and could access the recordings • **Test Process:** Login into the system with doctor role, access diagnosis report • **Test Data:** DoctoreID, Password, voice recording	• **Expected Result: Doctor should be able to review the diagnosis report by PDT** • **Actual Result: Tested as expected** • **Pass**

System testing is done to check whether the software or product meets the specified requirements

or not. To evaluate the end-to-end system, we mainly focus on our users and follow usability testing. System testing is done by the testing group and later acceptance testing is aiming to check whether the software meets the customer requirements or not. For acceptance testing we will follow the process of analysis of business. requirements, identify test scenarios and test cases, preparation of test data, run and record the results, and confirm business objectives met. Since acceptance testing is done by the actual end users, we plan to provide a demo system for our sponsor and clients and collect feedback from them.

Basic Documentation:

Parkinson's Disease Tech allows patients' access from smartphones, which can vastly improve the quality of care you're able to offer to Parkinson patients. Parkinson Disease Tech mainly focuses on four functions. First, the system could upload a patient's voice record from the application and the algorithm will transform the voice record into detailed diagnosis reports. Second, the patients and companions could easily access the reports and therapy recommendations. Third, the doctor could access the diagnosis report outputted by the system and make further diagnosis reports. Parkinson Disease Tech is a preferred method for creating patient reports and providing convenience.

Lessons learned

Through this project, we learned and practiced the process of planning and designing a system. During the project, our project plan and schedule were well-documented and clearly-explained, with appropriate structure and detail. During project planning and execution, the project schedule is on-track, and changes have been manageable, and our project environment is collaborative. Above all, the project team receives a lot of interaction internally and from the sponsor. We believe that our project plan is achievable, and Parkinson's Disease Tech will keep being updated to enhance the quality of patient’s life with and beyond Parkinson.

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